MIPT Data Visualization Course

Data Visualization in Modern Machine Learning

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Motivation

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- ▶ It's a little bit sad, but we can plot only 2D data, isn't it?
- ▶ A goal of data visualization is to understand inner data structure.
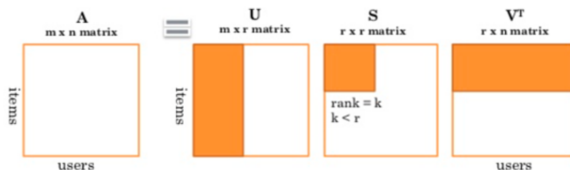- ▶ Or represent data in a much more interpretable form.

There are two way to get this goal:
- ▶ Low Rank Way (SVD, Auto-encoders, LDA, etc.)
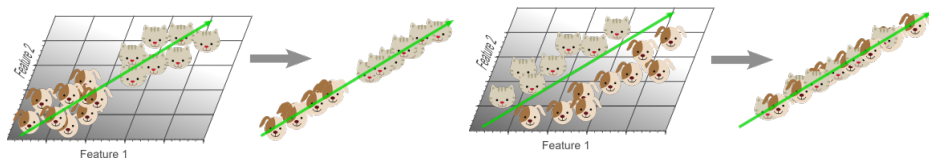- ▶ Generative Models Way (GAN, Image Capturing, etc.)

Low Rank idea

- ▶ We have matrix $X_{items \times features}$
- ▶ Let's try to represent each item's vector as smaller ones.
- ▶ What should we do?

Principal component analysis is a matrix decomposition

Intuition save maximum data variance, minimize L_2 norm
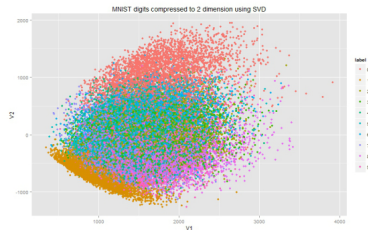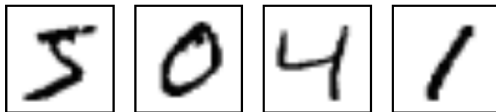
SVD: Faces dataset

Main components:

First centered Olivetti faces
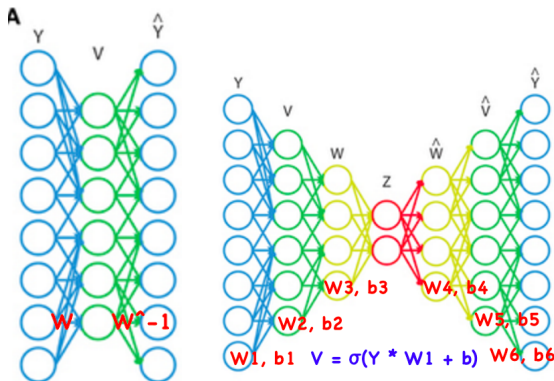
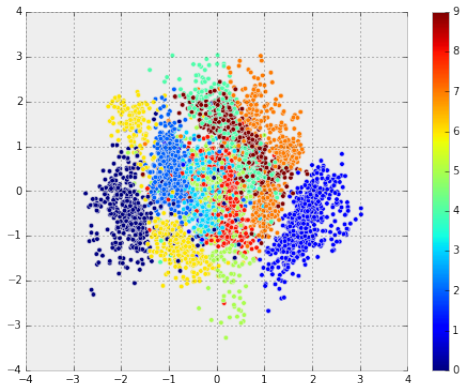genfaces - PCA using randomized SVD - Train time 0.1

Plot in 2d:

Non-linear generalization

- What did we do wrong? Our picture mixes different classes and so on.
- Let's try nonlinear generalization.

- How to find W_n, b_n?
- Define loss function $L(Y, \hat{Y})$ and use your favourite opt method.
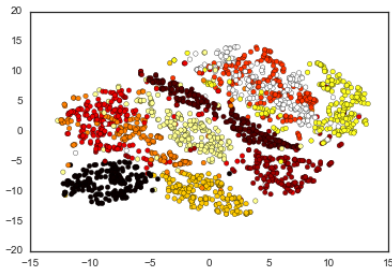
Auto encoders example

http://dpkingma.com/sgvb_mnist_demo/demo.html

Stochastic Neighbor Embedding

X – high dimensional obj and Y – low dimensional ones, σ – width params

$$p_{j|i} = \frac{\exp(-\|\mathbf{x}_i - \mathbf{x}_j\|^2/2\sigma_i^2)}{\sum_{k \neq i} \exp(-\|\mathbf{x}_i - \mathbf{x}_k\|^2/2\sigma_i^2)} \quad q_{j|i} = \frac{(-\|\mathbf{y}_i - \mathbf{y}_j\|^2)}{\sum_{k \neq i}(-\|\mathbf{y}_i - \mathbf{y}_k\|^2)}$$
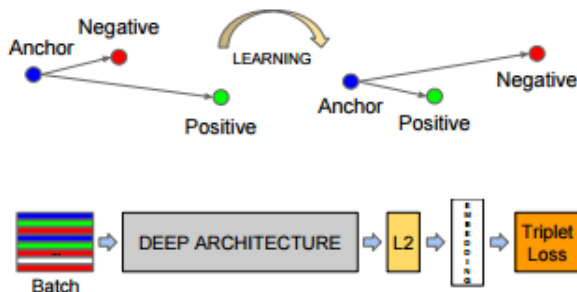
$$KL(P\|Q) = \sum_j \sum_i p_{i|j} \log \frac{p_{i|j}}{q_{i|j}} \to \min_q$$

Deep Neural Nets + t-SNE (modification of SNE with Student test):
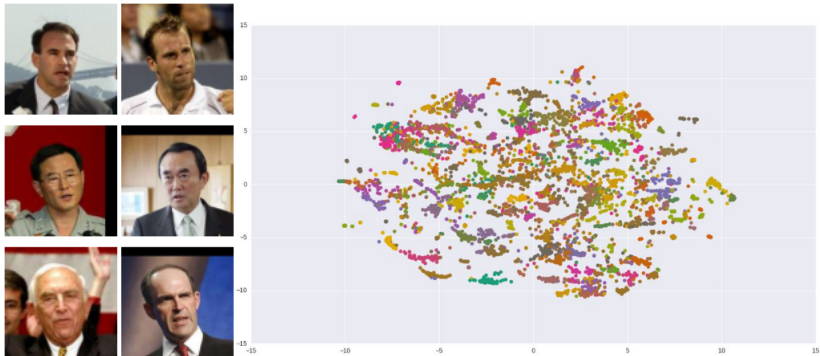http://cs.stanford.edu/people/karpathy/cnnembed/

DNN Metric Learning Triplet Loss
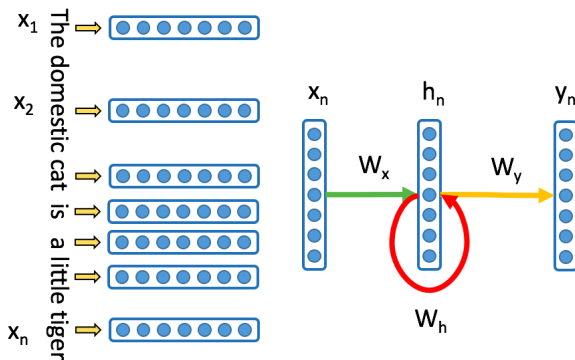

The loss that is being minimized is then

$$\sum_{i}^{N} \left[\|f(x_i^a) - f(x_i^p)\|_2^2 - \|f(x_i^a) - f(x_i^n)\|_2^2 + \alpha \right]_{+}$$

DNN Metric Learning Triplet Face and Music

High level

- We have mapped each object into vector
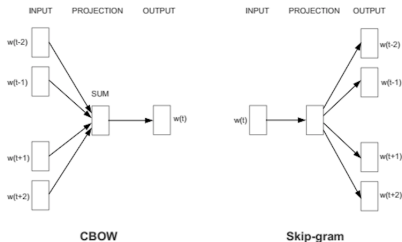- Let's train this vector for match complex object like words

$$h_n = W_x x_n + W_h \sigma(h_{n-1})$$

$$y_n = \sigma(W_y h_n)$$

Word2Vec

▶ Shallow Neural Net

CBOW   Skip-gram

▶ Operations on embeddings are great

vec("man") – vec("king") + vec("woman") = vec("queen")

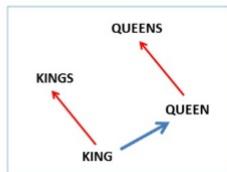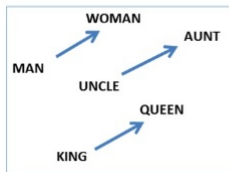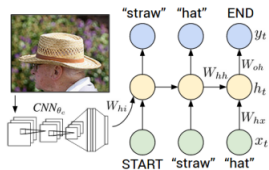http://turbomaze.github.io/word2vecjson/

Image2Text

- ▶ Ok, we have a picture and want to represent in lower dim space
- ▶ Let's try to map picture to words sentence

man in black shirt is playing guitar.

construction worker in orange safety vest is working on road.
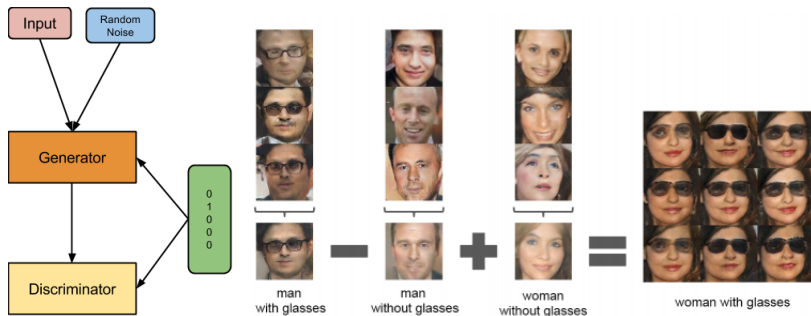
two young girls are playing with lego toy.
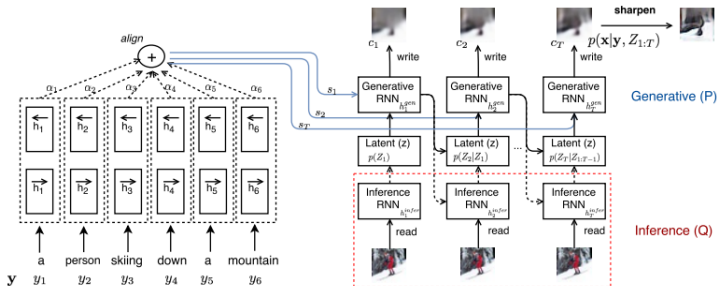
boy is doing backflip on wakeboard.

http://cs.stanford.edu/people/karpathy/deepimagesent/
http://cs.stanford.edu/people/karpathy/deepimagesent/rankingdemo/
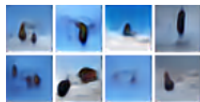
Generative Adversarial Networks

- Image Generation is a lintel bit hardcore
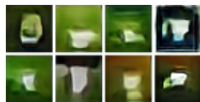- Most modern idea is like this

Text2Image

A stop sign is flying in blue skies.

A herd of elephants flying in the blue skies.

A toilet seat sits open in the grass field.

A person skiing on sand clad vast desert.

https://arxiv.org/pdf/1511.02793v2.pdf

References